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Culturally-Sensitive Human-Robot Interaction: A Case Study with the Pepper Humanoid Robot

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Africa needs technological **innovation** in AI and Robotics to foster its economic development

Innovation = **Invention** + **Adoption**

Adoption depends on **trust**

Trust depends on **social infrastructure**



- Social conventions
- Cultural norms
- What people find acceptable or not

To be trusted and adopted, technological inventions must be
sensitive to socio-cultural norms

Social robots will help humans solve some critical issues in Africa in several social settings (hospitals, hotels, schools and more)



Humans use verbal, nonverbal and spatial cues to interact with their human counterparts.
So must social robots if there are to be effective

Social robots must be culturally-sensitive for an effective human-robot interaction

Socio-cultural norms determine the acceptance of social robots and the effectiveness of their interaction

Objectives

- (i) Identify the verbal and non-verbal social and cultural norms of human interaction that are prevalent in different countries in Africa
- (ii) Show how they can be encapsulated in the behavioral patterns of social robots so that they can engage with African people in a manner that is consistent with expectations of acceptable social interaction
- (iii) Demonstrate these culturally-sensitive social robot behaviors in a university laboratory tour

Outcomes

- (i) A set of software interaction primitives
- (ii) A system architecture comprising the components required for culturally-sensitive human-robot interaction in Africa
- (iii) A ROS-based reusable and reconfigurable application that generates a small extensible set of culturally sensitive behaviors

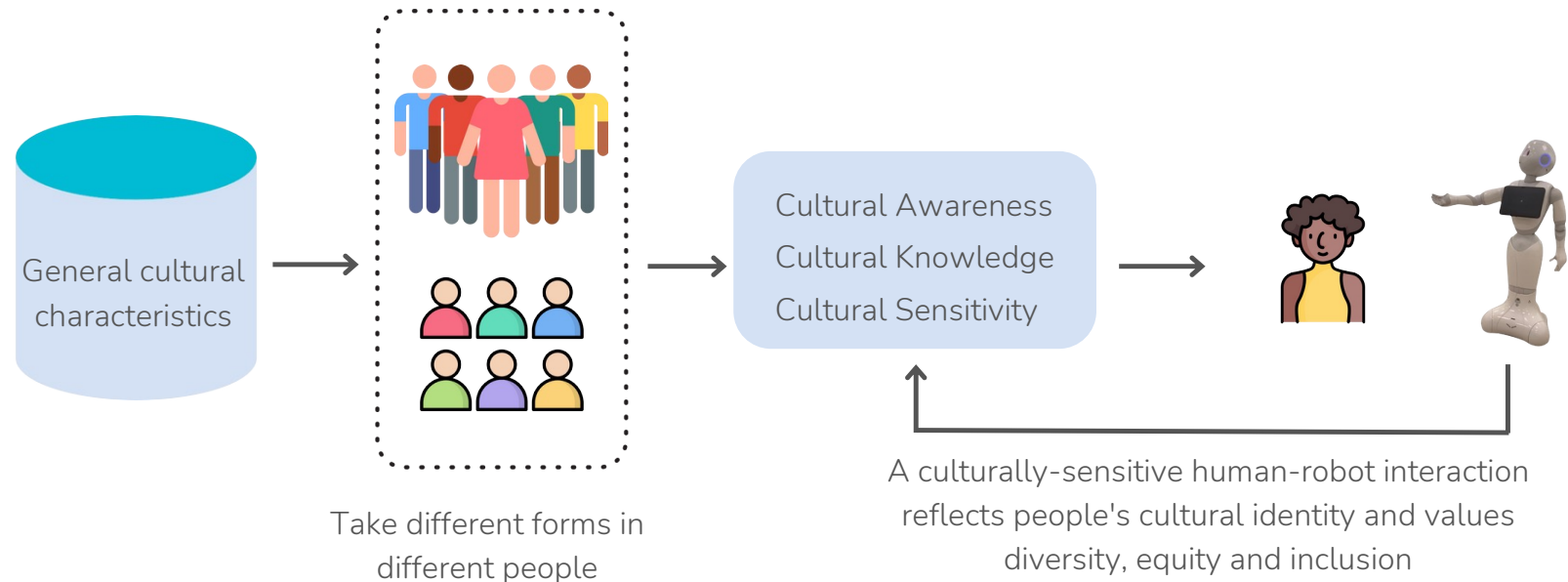
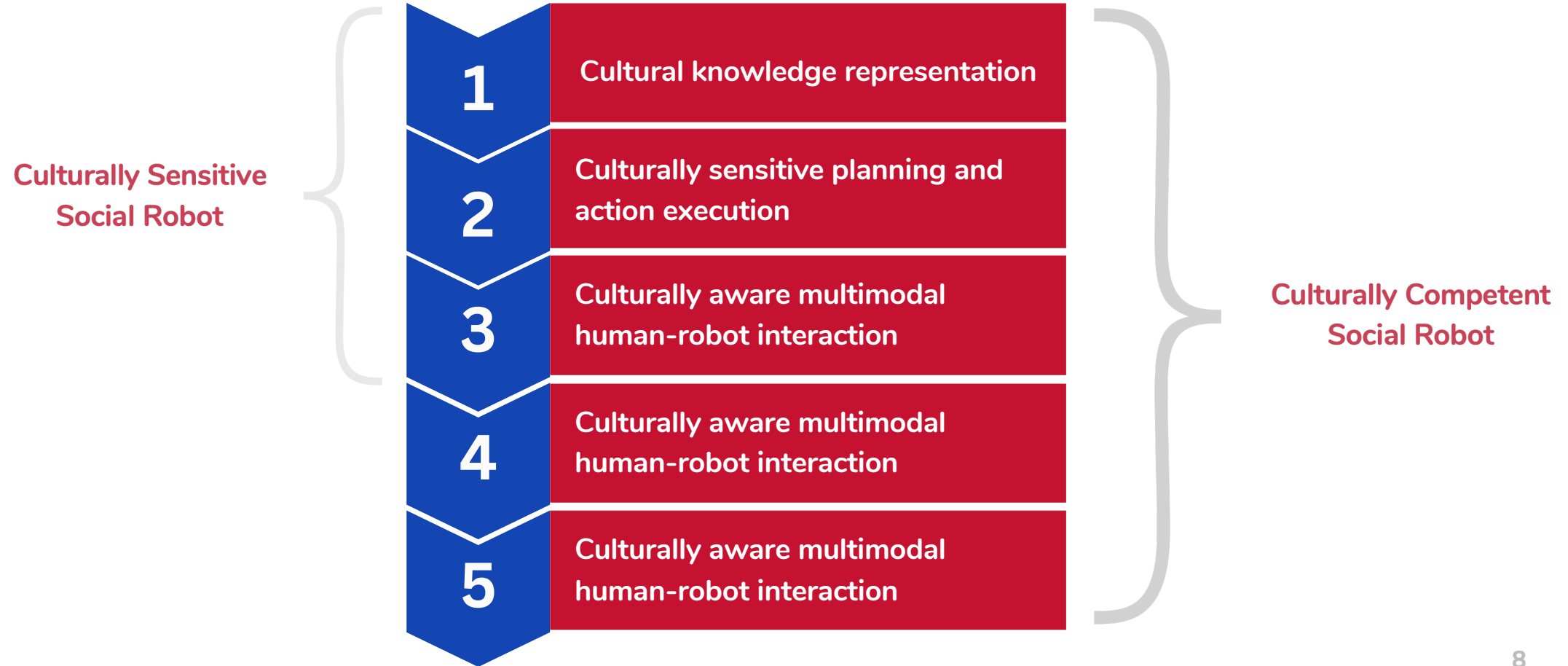


Fig 1. Key elements of a culturally-sensitive robot

“Culture is a set of social norms and expectations that reflect shared educational and life experiences associated with national differences or distinct cohorts of workers”
(Lee and See, 2004)



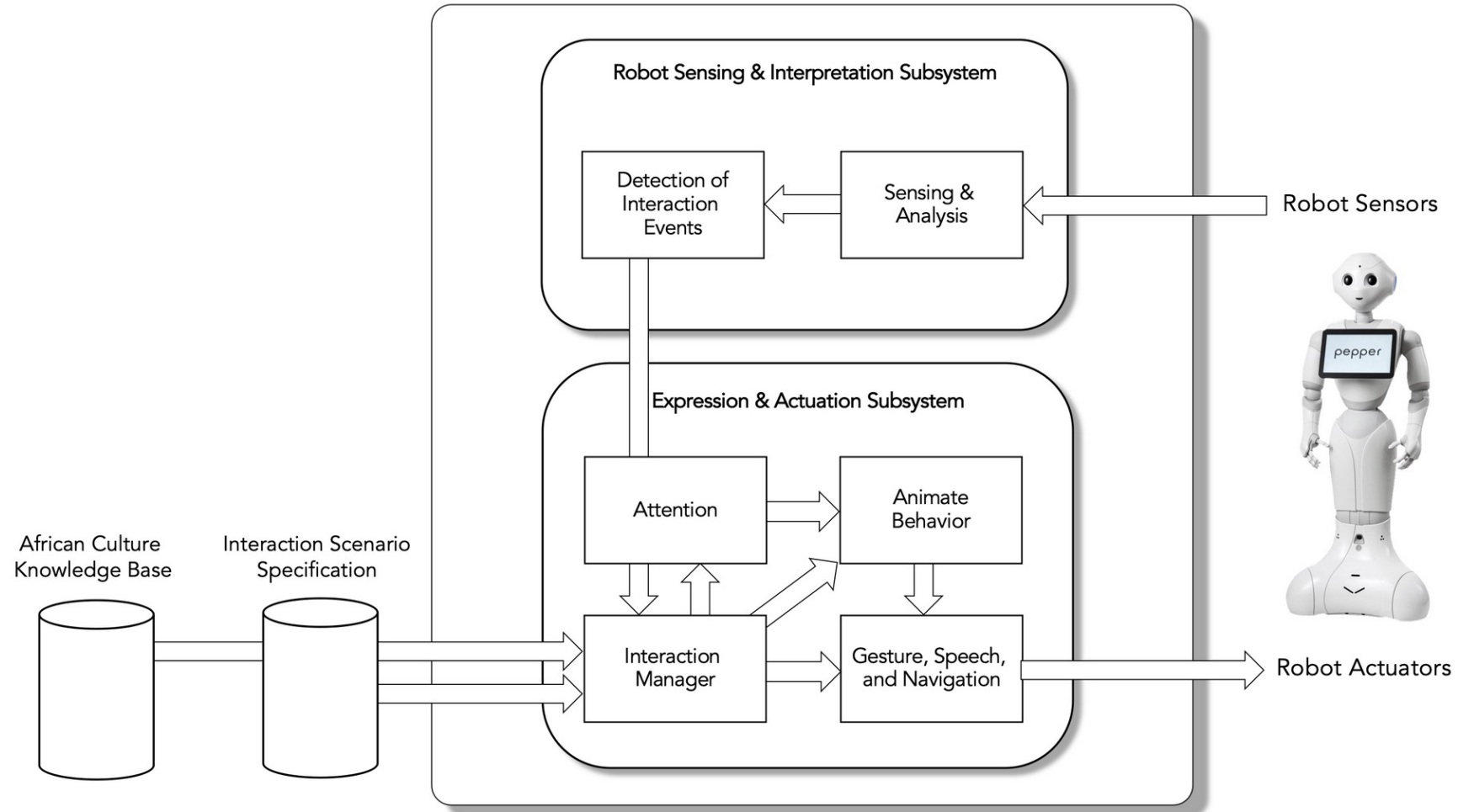


Fig 2. System architecture of the different elements for culturally-sensitive human-robot interaction

N	Socio-Cultural Norm or Trait
1	All interactions should begin with a courteous greeting.
5	To show respect, one should bow slightly and lower gaze when greeting someone older.
8	One should use an open palm of the hand to point to people and objects.
10	One should not use the left hand to hand something to someone.
11	One should not use the left hand to point to anything.
21	To show respect, one should shake hands with the right hand.
25	Behaviours should focus on fostering social connections and relationships; they should not be purely functional.

Table 1. A sample of African culture-specific knowledge (Vernon, 2023)

<p>Description: A guest visits the CMU-Africa campus. She stopped by the CMU-Africa robotics lab. The social robot Pepper gives a tour of the lab.</p> <p>Initial lab setting: The humanoid robot Pepper is in the lab. The only other occupant of the lab is a lecturer.</p>		
Scenario	Robot skills	Culture-sensitivity
<p><i>The guest enters the robotics lab</i></p> <p>Guest: Hello! My name is Hilary. Can you please tell me what you do here?</p> <p><i>Professor Busogi welcomes the guest and introduces what students study and work on in the lab. He kindly asks the guest to come up to the robot as he introduces the Human-Robot Interaction (HRI) research project that is going on in the lab</i></p>	<p>Moving (head, arms, torso, hip)</p>	<p>[Culture-generic]: Pepper knows that you should initiate a greeting and welcome a guest.</p> <p>[Culture-specific]: Pepper knows that in Africa you should initiate a polite greeting by bowing your head and chest.</p> <p>[Culture-generic]: Pepper knows that you should extend your hands to greet and welcome the guest and make eye contact when greeting someone.</p>

Table 2. University laboratory tour scenario

Type of Interaction	Software Primitives	Description of Cultural Parameters
Deictic gestures	<pre>show_head_gaze_eye_contact(robot_joint, angular_velocitie, waypoints) show_head_gaze_joint_attention(robot_joint, angular_velocitie, waypoints))</pre>	<p><i>joint</i>: Array of robots joints names. The robot joints are actuated for it to describe a motion. e.g. LShoulderPitch, LShoulderRoll, HeadPitch, HeadYaw.</p> <p><i>angular_velocities</i>: array of angular_velocities (in rad/s) for each joint specified in the <i>robot_joints</i> parameter.</p> <p><i>waypoints</i>: 2D array specifying a sequence of joint values (in rad) for each of the joints specified in the <i>robot_joints</i> parameter.</p>
Symbolic gestures	<pre>welcome(robot_joints, angular_velocities, waypoints) greeting_arm_extension(robot_joints, angulart_velocities, waypoints)</pre>	
Gaze	<pre>show_head_gaze_eye_contact(robot_joint, angular_velocities, waypoints) show_head_gaze_joint_attention(robot_joint, angular_velocities, waypoints)</pre>	
Posture	<pre>bow(robot_joints, angular_velocities, waypoints)</pre>	

Table 3. Interaction software primitives



Evaluation through a Robotic Social Attributes Scale (RoSAS) survey that included 35 participants

Scores	1	2	3	4	5	6	7	Num Replies
Compassionate	0	2	1	2	2	1	3	11
Interactive	0	2	2	3	0	1	2	10
Social	1	0	1	0	4	2	2	10
Competent	0	1	1	3	2	1	2	10
Reliable	0	0	2	2	4	0	2	10
Total Score	1	5	7	10	12	5	11	51

Table 4. RoSAS survey results

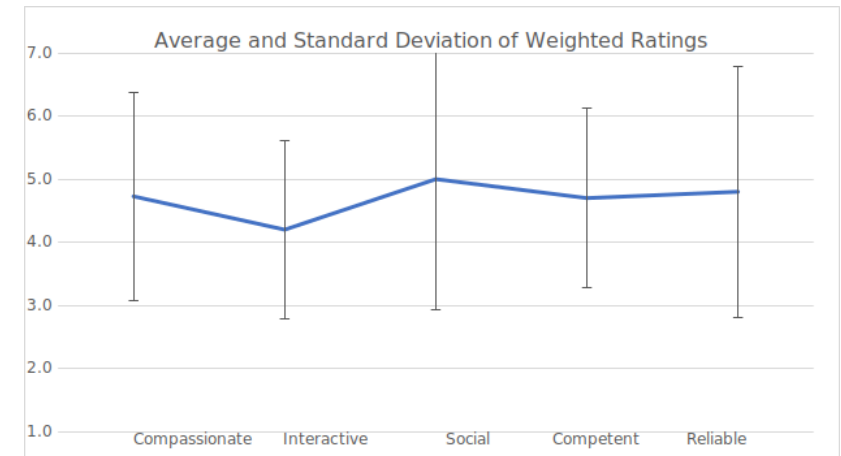


Fig 3. Average and standard deviation of weighted ratings.

This evaluation was based on a small sample of behaviors and that the exercise was merely a trial, and involved a small number of respondents. As such, we anticipate less neutral responses when we evaluate a full set of culturally-sensitive behaviors in the tour scenarios with a much larger group of respondents.

Future work

- Carry out a detailed ethnographic study to identify a more complete knowledge-base of cultural knowledge
- Expand the set of software primitives, to extend the suite of culturally-sensitive behaviors
- Evaluate the efficacy of these behaviors through extensive empirical tests involving people from different African cultures, initially restricting our focus to Rwanda and South Africa

This work is now part of the Culturally Sensitive Social Robotics for Africa (CSSR4Africa) project. Please visit the project website for more information: cssr4africa.org

Join us at a workshop on Culturally Sensitive Social Robotics for Africa & the Middle East (CSSR4All) on December 5 at the 23rd International Conference on Advanced Robotics Abu Dhabi, UAE: cssr4all.org

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